Ontario

Ministry of the Environment

Water Resources
Map 3106

Ground Water Probability

County of Elgin

Ontario

MINISTRY OF THE ENVIRONMENT

Water Quantity Management Branch

GROUND WATER PROBABILITY ELGIN COUNTY

DESCRIPTIVE NOTES

INTRODUCTION

Although Elgin County borders Lake Erie and several communities obtain water from the lake, ground water is an important source of supply in much of the county.

The purpose of this publication is to indicate the probable water yield from wells, the probable depths to the water-yielding formations, areas where shallow wells and sand points may be developed, and the water quality at sampled locations in the County of Elgin.

Two maps are provided to show the ground water probability for the county: one shows the probable yields in deep and shallow water-yielding formations and the other the probable yields of formations at intermediate depths. Two small maps showing the bedrock geology and topography and the thickness of the overburden in the county are included.

The maps were compiled from nearly two thousand water-well records on file with the Ontario Ministry of the Environment, oil and gas well data compiled by the Petroleum Resources Section of the Ontario Ministry of Natural Resources, and other miscellaneous water resources studies. Chemical quality data are presented for a number of wells which were selected to represent typical quality conditions in the most commonly used aquifers.

USE OF PROBABILITY MAPS

In evaluating prospective well sites both probability maps should be used to determine whether deep, intermediate or shallow aquifers (water-yielding formations) will meet the requirements of the proposed use.

Follow these steps:

1. *Locate the area of the proposed well site on map 3106-1 (Deep and shallow aquifers).*
2. *Note the depth from ground level to the top of the deep aquifer; these are the blue contour lines at 25 ft. intervals.*
3. *Check the probable well yield by reference to the colour legend.*
4. *To determine whether the deep aquifer is in the rock or overburden, compare the depth to the top of the aquifer with the thickness of overburden which is shown on Map 3106-4.*
5. *Note the areas in which shallow aquifers are present; only the extent of shallow aquifers are shown. Yields and depths shown are for the deep aquifers.*
6. *Check the likely water quality by locating nearby sampling points and checking analyses in the tables; for deep aquifers use tables 1 and 2 and for shallow aquifers use tables 3 and 4.*
7. *Repeat steps 1 to 3 for Map 3106-2 (Intermediate aquifers).*
8. *Check the likely water quality by locating nearby sampling points and checking analyses in tables 5 and 6.*
9. *Determine whether your needs will be met by investigating the deep, intermediate or shallow aquifer.*

Probability Ranges

Yields are indicated in four ranges with comments on adequacy of each range:

less than 2 gpm—inadequate to marginal for most purposes.

2-10 gpm—marginal to adequate for domestic or stock purposes.

10-50 gpm—adequate for most commercial, small industrial and farming purposes.

greater than 50 gpm—adequate for most irrigative and many industrial and municipal uses.

An area was placed in a certain probability range if more than 50 per cent of the wells in that area had calculated yields within that range. A well drilled within an area of a particular range may not necessarily produce at a rate within that range, but there is a better than 50 per cent chance that it will. The ranges were determined from reported, short-term pumping tests and may not necessarily represent long-term yields. A more reliable determination of well and aquifer yields requires information from pumping tests and detailed hydrogeologic investigations.

The depth from land surface to the top of the deep and of the commonly used intermediate water-bearing formations is shown using 25-foot contours.

Map 3106-1 shows the yield, depths and water quality sampling points of aquifers in the upper part of the bedrock and in the deep overburden aquifers. Also indicated on the map are areas where surface sands or sand layers in the upper portion of the overburden are known to yield adequate water supplies for household purposes from sandpoints or bored wells. These areas are outlined by a dotted pattern which is superimposed over the deep aquifer probability ranges. The probable yields for these shallow sand aquifers are not indicated on the map, but water quality sampling points in the shallow aquifers are indicated.

The three cross-sections, along lines A_1-A_2, B_1-B_2 and C_1-C_2 show the major overburden materials, depths where water was found, static water levels, and depths to the bedrock where wells go that deep. They provide a general picture of the nature of the geologic deposits and the locations of water-yielding horizons beneath the land surface.

Map 3106-2 shows the probable yield, depths and water quality sampling points of intermediate aquifers in the overburden. In areas where there are more than one intermediate aquifer the most commonly used intermediate aquifer is depicted; other similar deposits may be present at greater or lesser depths.

The contours indicating the depth of the water-bearing formations are more accurate where the land surface is flat than in the valleys of the larger streams where the contours are approximate due to the rapid changes in ground elevation.

Water quality diagrams indicating the major chemical parameters are shown for those sampling points with the more comprehensive chemical analyses.

HYDROGEOLOGY

Geology

The bedrock underlying the county is composed of sedimentary rocks of three major formation units of Middle Devonian age. Map 3106-3 shows the bedrock geology and topography. The oldest rocks are brown, finely crystalline limestones containing some quartz sand grains and chert of the Dundee Formation. These rocks underlie the overburden in the north-central and northeastern parts of the county and occur locally in the Township of Aldborough and in the south-central area of the county.

In the southern and southeastern parts of the county the bedrock is composed of black bituminous shales with minor limestone content of the Marcellus Formation.

Grey shales with limestone beds form the bedrock in most parts of the Township of Aldborough and in the greater part of the Township of Dunwich. These rocks are part of the Hamilton Group of formations.

Most of the overburden is composed of glacial drift, mainly clays, clay tills, buried sand and gravel deposits, and extensive surface sand deposits. The thickness of overburden varies from about 50 feet in the valley of the Thames River to over 450 feet in the south-central part of Yarmouth Township (Map 3106-4). The common thickness is between 250 feet and 300 feet.

Geomorphologically the county can be divided into four regions. In the western part, the Bothwell sand plain dominates the topography, and in the southeastern part of the county, the flat area of the Norfolk sand plain comprises the land surface. Both sand plains are deltaic in origin and were deposited in glacial lakes Whittlesey (Norfolk sands) and Warren (Bothwell sands). Large areas in the townships of Dunwich, Southwold and Yarmouth are covered by the Ekfrid clay plain which was also deposited in glacial lakes. The topography of the northwestern region and parts of the central area of the county is dominated by the St. Thomas, Norwich and Tillsonburg moraines. These moraines were deposited by the receding ice sheet of the Wisconsinan glaciation. Local relief may be over 100 feet in places. Glacio-fluvial, spillway deposits of silt and some sand and gravel fill the valleys between the moraines in the Township of South Dorchester.

Occurrence of Water

The occurrence of ground water depends on the distribution of certain geologic units which can store and transmit water readily. Water-bearing formations which yield water in usable quantities are known as aquifers.

Aquifers in the area include the limestone and shale bedrock and most of the sands and gravels in the overburden.

A deep artesian aquifer is present in most parts of the county. It comprises the upper part of the bedrock and sands and gravels in the lower part of the overburden. Where the bedrock surface is not overlain by sands and gravels well yields are generally lower. Yields from the bedrock are lower in the western and southern parts of the county, where the bedrock

is composed mainly of shale. Higher yields are obtained generally in the northeastern part of the county and from deep sands and gravels west of Rodney.

Very often water from the deep aquifer contains hydrogen sulphide or excessive iron. Some wells which were fresh during drilling became sulphurous after intensive pumping.

The intermediate aquifers are generally artesian and occur at different depths in various areas of the county. They occur mainly in the westernmost, northern, central and eastern parts of the county. They consist of gravel, sandy gravel, and medium-to-fine-grained sand. Some deposits may have a large horizontal extent but changes in grain size may make the same deposit a good aquifer in one area and a poor one in another.

The shallow aquifers are generally unconfined, water-table aquifers. They are widespread in the sand plain areas of the western, south-central, southeastern and eastern parts of the county. Many dug, bored and driven wells are used for domestic water supplies. The depths of these wells rarely exceed 60 feet. In some areas the shallow aquifer may be partly confined due to changes in the nature of the deposits. Water in the shallow aquifers is very hard; generally harder than water in the deeper aquifers. Several shallow wells with high nitrate content indicate contamination from surface sources.

In general, ground water is available in adequate quantity and quality in most parts of the county. In some areas wells may be as deep as 300 feet. About 10 per cent of the wells drilled in the county were reported to be dry or to yield insufficient water.

Water Quality

The results of 86 water quality analyses in the laboratory and of 44 analyses in the field are listed in Tables 1 to 6. Tables 1 and 2 contain analyses of samples from deep aquifers, Tables 3 and 4 from shallow aquifers and Tables 5 and 6 from intermediate aquifers. The tables accompany the respective probability maps. The 44 field samples were analyzed for 6 parameters. The laboratory analyses are more comprehensive, 48 of them were done specifically for this report and 38 are from previous ground-water studies.

Scaled diagrams on the maps indicate the locations and the concentration of seven water quality parameters for 65 samples.

The quality of ground water is generally good in the county. The best quality is obtained from the intermediate aquifers. The deep aquifers sometimes yield water containing hydrogen sulphide (H_2S) and the shallow aquifers commonly yield very hard water.

The analyses for the wells in the deep, intermediate and shallow aquifers were compared and the results listed in the Table 7 below. Evident from the table are the high proportion of deep wells with high H_2S and iron and the high proportion of shallow wells with hard water. The pH values are relatively uniform for wells from all three types of aquifer.

Table 7. Comparison of Water Quality in Different Aquifers

Aquifer Type	pH at Lab	Wells tested for H_2S		Percentage of wells having concentration in parts per million in excess of the values shown for each parameter							
		Number Sampled	Number Reporting H_2S	Iron as Fe	Boron as B	Sulphate as SO_4	Chloride as Cl	Fluoride as F	Nitrate as N	Hardness as $CaCO_3$	Total Dissolved Solids
				0.3*	1.0*	250*	250*	1.0**	10.0*	180***	500*
Deep	7.2—8.6	34	21	86	29	0	34	61	0	42	54
Inter-mediate	7.5—8.4	34	9	66	0	0	0	65	0	33	0
Shallow	7.2—8.4	25	0	44	0	0	5	0	26	91	44

* value of permissible criteria for public water supplies

** value of desirable criteria for public water supplies

*** value considered to be the lower limit of very hard water

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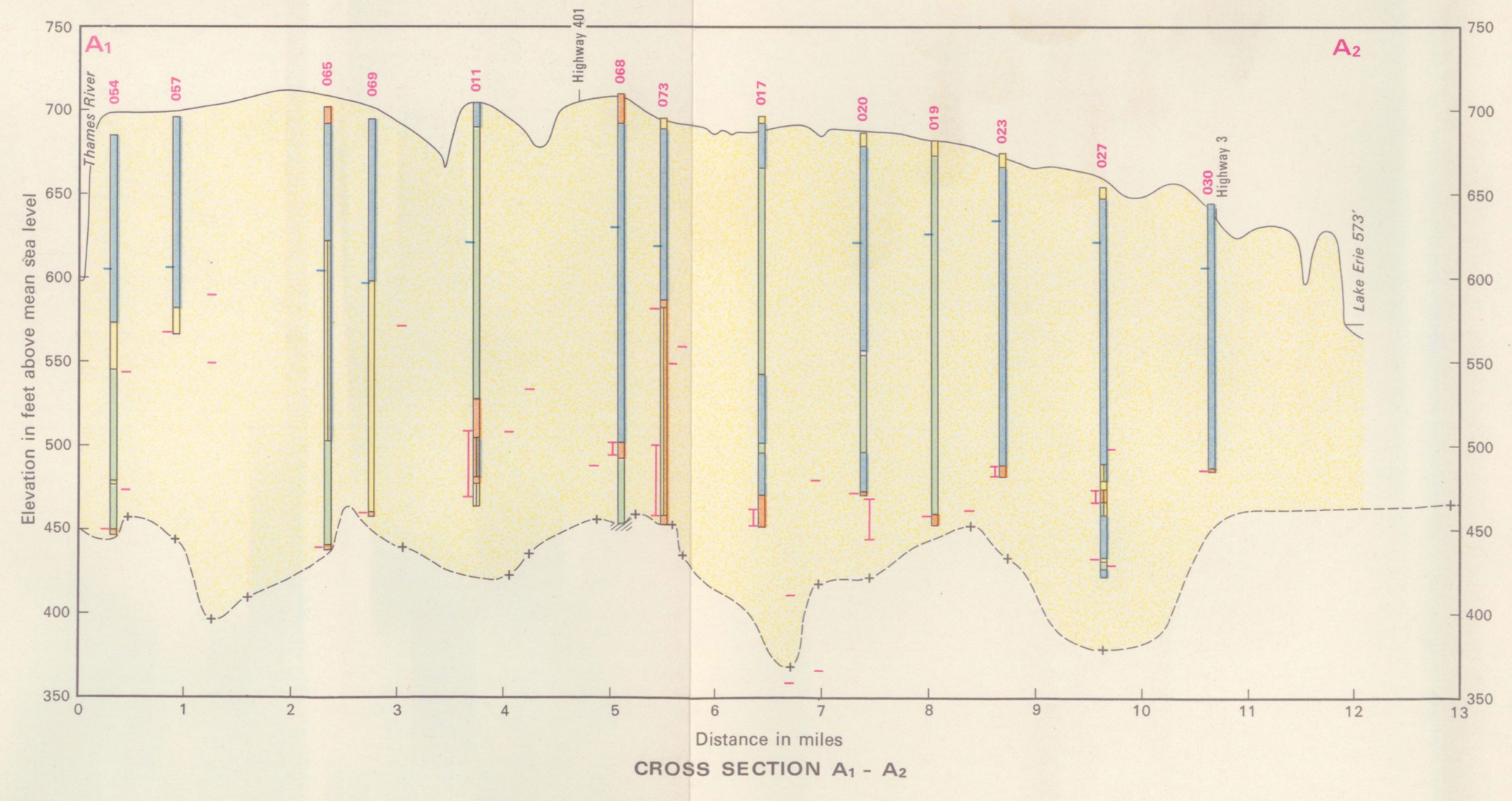
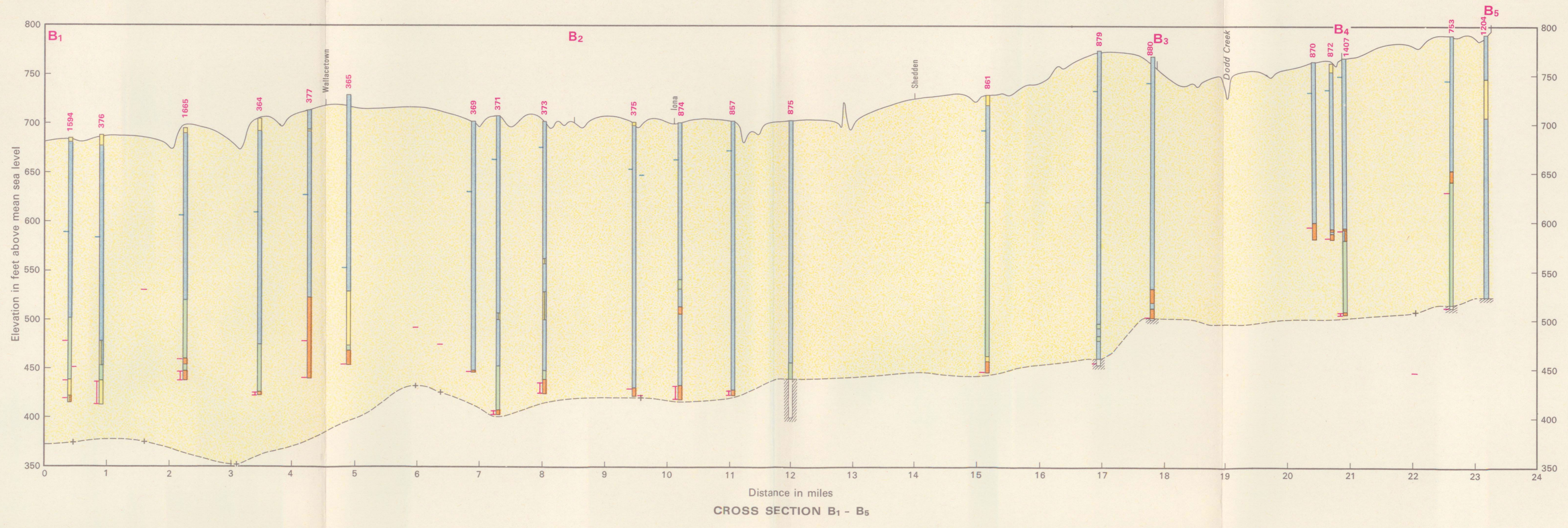


CROSS SECTION A_1 – A_2



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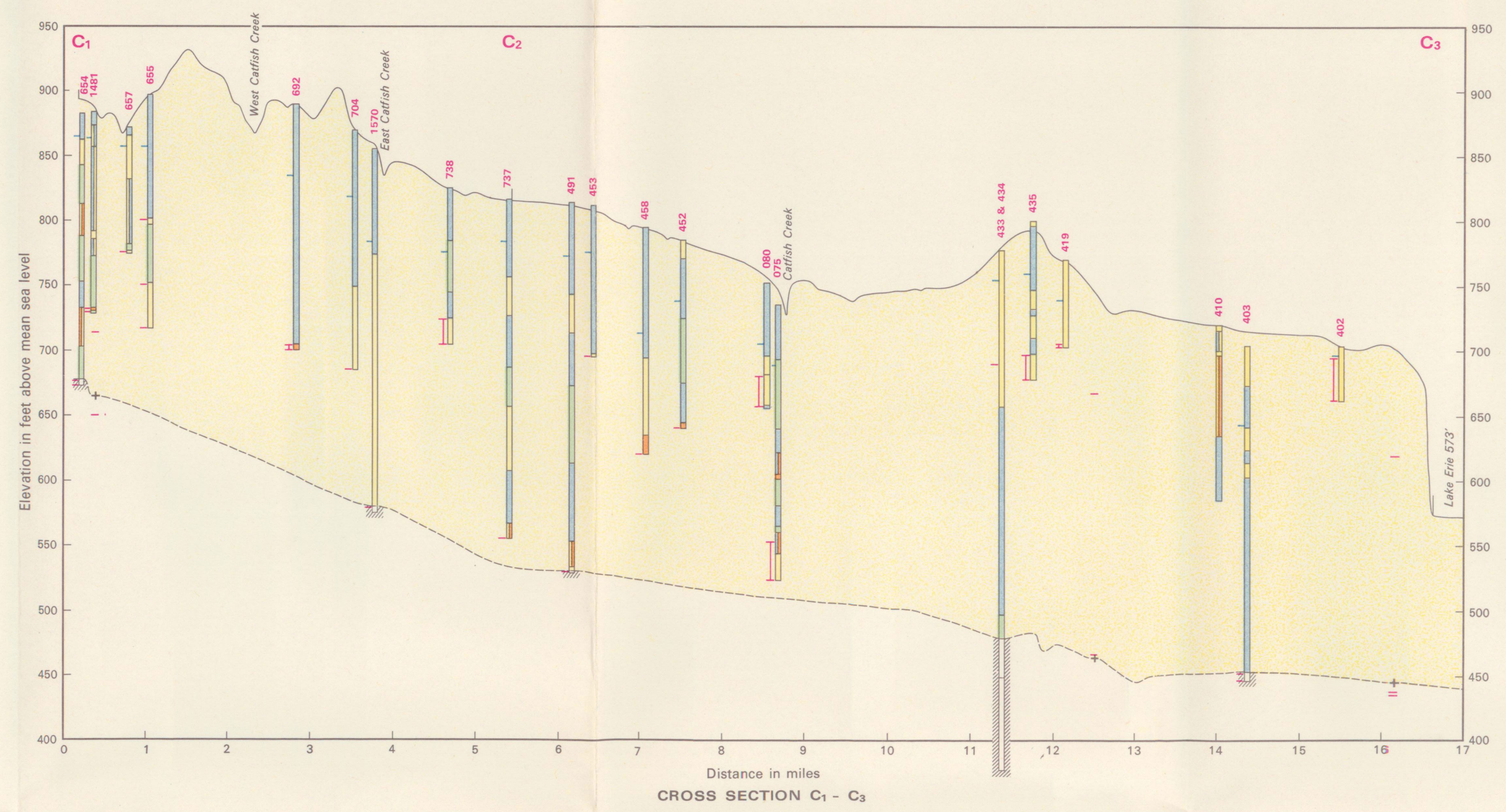

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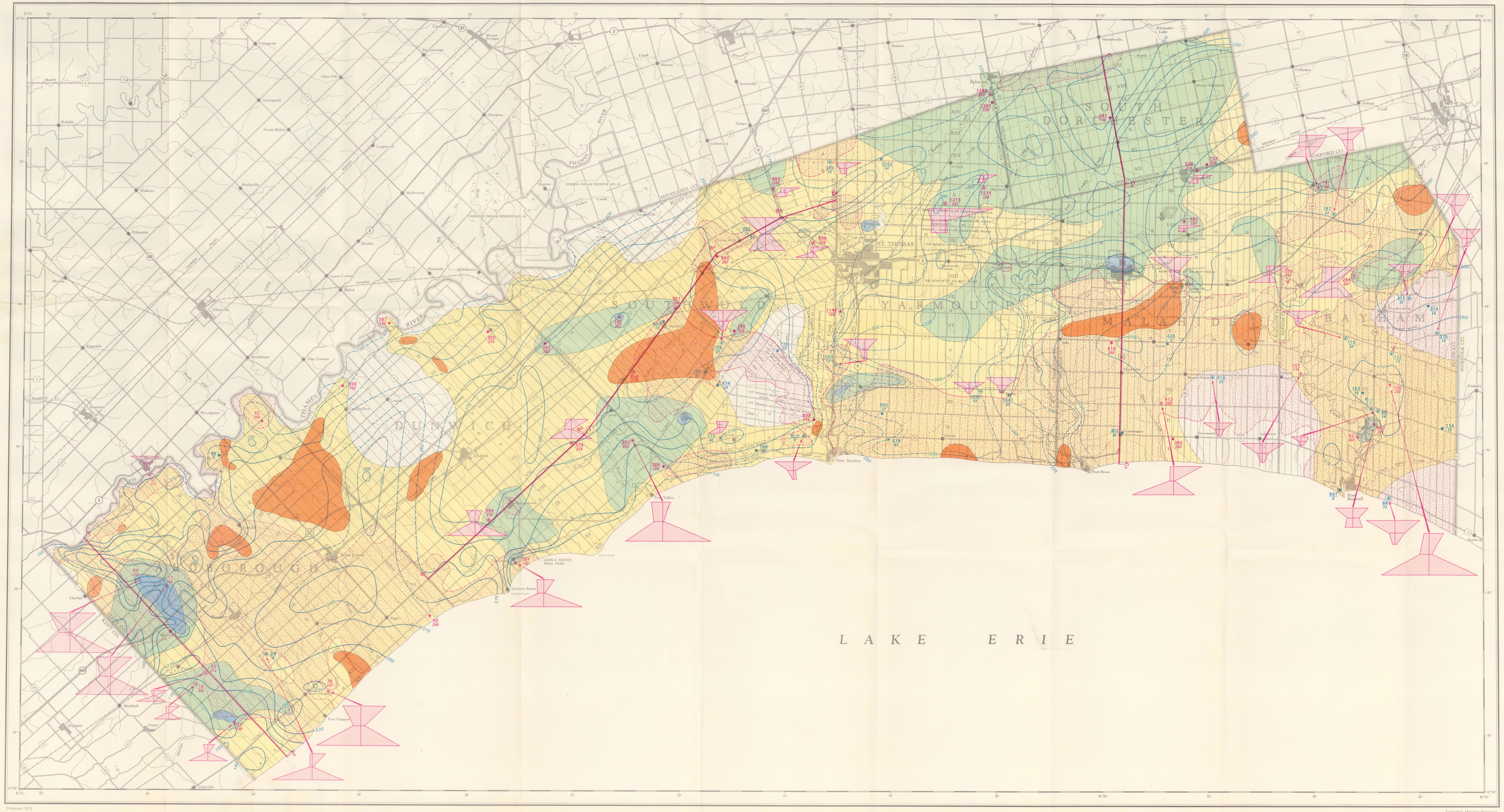


LEGEND FOR CROSS-SECTIONS

- Clay.
- Hardpan or clay and stones.
- Sand.
- Gravel.
- Overburden.
- Ground level.
- Static level.
- Assumed bedrock surface.
- Depth to water.
- Depth to water-bearing zone.
- Bedrock penetrated.
- Bedrock elevations obtained from oil and gas well records.
- 067 Well number.

Note: Water level elevations of Lake Erie are mean annual levels.

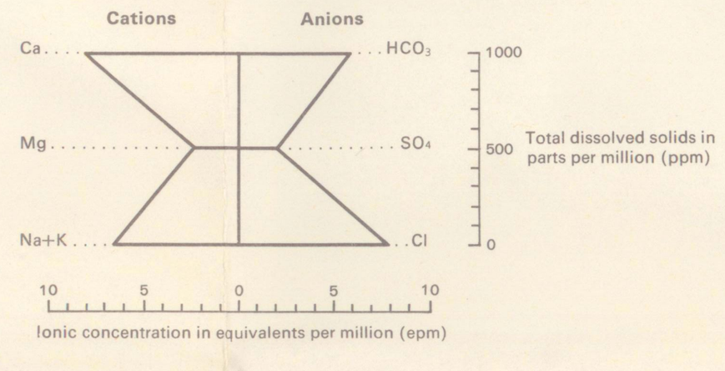
Horizontal scale 1:100,000

Vertical scale 1 inch = 100 feet.

LEGEND

- Areas where wells are likely to produce less than two gallons per minute. Difficulties are encountered in obtaining sufficient quantities of water for any purpose.
- Areas where wells are likely to produce two to ten gallons per minute. Supplies are generally adequate for domestic and stock purposes.
- Areas where wells are likely to produce ten to fifty gallons per minute. Supplies are generally plentiful for domestic and stock purposes, adequate for most commercial and small industrial purposes, but poor to fair as a supplemental source for irrigation.
- Areas where wells are likely to produce more than fifty gallons per minute. Supplies are generally adequate for most irrigation and many municipal uses.
- Areas where no information on the yield of the deep aquifer is available.
- Areas where surface or near-surface sands are present in the upper 25 feet of the overburden. Yields may be adequate for domestic and stock purposes. Outline of areas is defined from well records and surficial geology.
- Areas where surface or near-surface sands are present in the upper 25 feet of the overburden. Yields may be adequate for domestic and stock purposes. Outline of area is assumed, information is inadequate.

EXPLANATION OF WATER QUALITY DIAGRAM



CONVERSION FACTORS

Equivalents per million (epm) to parts per million or to milligrams per litre:

Ion	Multiply by
Bicarbonate (HCO_3)	61.01
Calcium (Ca)	20.04
Chloride (Cl)	35.46
Magnesium (Mg)	12.16
Potassium (K)	39.10
Sodium (Na)	23.00
Sulphate (SO_4)	48.04

SYMBOLS

- Line of equal depth to the deepest aquifer in the overburden or to the upper aquifer in the bedrock, interval 25 feet 150
- Assumed depth to the deepest aquifer in the overburden or to the upper aquifer in the bedrock, interval 25 feet 150
- Overburden well with laboratory analysis, deep aquifer
- Overburden well with field analysis, deep aquifer
- Bedrock well with laboratory analysis, deep aquifer
- Bedrock well with field analysis, deep aquifer
- Overburden well with laboratory analysis, shallow aquifer
- Overburden well with field analysis, shallow aquifer
- Sample and well number / Depth of water-yielding zone in feet .... 960 / 261
- Sample and well number / Depth of well in feet .... E-6 / 300
- not available .... E-1 / n.a.

Water quality diagram:

- Concentrations to scale

Topographic symbols:

- Multilane, limited access highway 401
- Provincial highway 78
- County road 25
- Other road
- Railway
- Perennial river or stream
- Intermittent stream
- Ditch
- Marsh or swamp
- County boundary
- Township boundary
- City, town or village limit
- Park or reserve boundary
- Concession line
- Lot line
- Built-up area
- Centre of settlement

SOURCES OF INFORMATION

Probability of ground water by A. A. Mellary and B. Novakovic, 1971.

Water samples taken by B. Novakovic, 1971.

Water samples analyzed by OWRC Laboratory and by B. Novakovic.

Well information from:

Water-well records on file with the Ontario Water Resources Commission.

Oil and gas well records published by the Petroleum Resources Section of the Ontario Department of Mines and Northern Affairs.

Base map derived from 1:25,000 and 1:50,000 sheets of the National Topographic Series, and from Ontario Department of Highways maps.

Cartography by R. Zimmermann, 1971.

CHEMICAL ANALYSES OF WATER SAMPLES

Table 1. Laboratory Analyses—Deep Aquifers

Sample or Well Number	Date	H_2S at Field	pH at Lab	Constituents in parts per million (ppm)											Sodium Adsorption Ratio	Alkalinity as ppm $CaCO_3$	Total Hardness as ppm $CaCO_3$	Total Dissolved Solids (ppm)	Specific Conductance (micromhos at 25°C)
				Total Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Boron (B)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (N)					
11	13/10/70	–	7.5	6.60	74	35	201	3.5	–	346	1	354	–	< 0.01	4.82	284	328	970	–
18	13/10/70	0.1	8.2	1.10	19	7	89	1.0	–	150	1	107	–	< 0.01	4.42	123	76	320	–
20	20/7/71	0.0	8.0	0.30	15	5	104	1.0	1.0	178	< 5	102	1.2	0.04	5.94	146	58	290	571
27	19/7/71	0.0	8.0	0.35	23	8	113	1.6	0.74	107	< 5	183	1.4	< 0.01	5.17	88	92	410	758
38	20/7/71	0.0	7.3	3.4	93	22	183	135	0.67	380	61	358	0.3	3.1	4.44	312	324	1000	1635
51	20/7/71	0.0	7.7	0.05	85	10	10	2.3	0.10	188	25	25	0.1	0.10	0.27	154	252	370	509
69	20/7/71	0.0	7.3	8.5	101	34	202	4.4	1.2	385	< 5	379	1.1	–	4.44	316	392	1000	1660
92	24/3/63	–	7.7	2.56	–	–	–	–	–	393	–	165	–	–	–	322	170	–	–
101	30/6/65	–	7.7	0.20	111	18	6	1.5	–	352	71	13	–	2.0	0.14	289	354	516	600
108	30/6/65	–	8.3	36.0	30	32	280	3.2	–	216	30	440	–	0.0	8.46	177	210	1064	1490
191	30/6/65	–	8.6	1.7	35	24	105	1.8	–	316	174	30	–	0.0	3.35	259	186	566	660
235	30/6/65	–	8.1	0.71	16	8	125	2.3	–	285	9	56	–	0.0	6.37	234	82	434	510
284	30/6/65	–	8.0	3.9	52	35	195	5.3	–	341	83	202	–	0.0	5.12	280	274	784	1150
364	21/7/71	0.0	8.3	1.1	42	13	164	1.3	0.56	115	< 5	303	0.8	< 0.01	5.66	94	158	650	1091
374	21/7/71	0.4	7.9	0.45	30	21	129	4.1	1.5	251	< 5	178	1.1	< 0.01	4.41	206	162	490	904
382	21/7/71	0.0	7.9	0.25	56	26	222	1.8	0.62	112	< 5	450	0.7	< 0.01	6.15	92	248	1000	1500
384	21/7/71	0.0	7.9	0.40	35	20	198	2.0	0.66	163	< 5	337	1.1	< 0.01	6.61	134	170	690	1245
413	27/7/71	0.3	8.3	3.0	18	12	241	5.4	3.4	449	< 5	201	1.9	< 0.01	10.78	368	92	720	1236
482	29/7/71	1.0	7.9	0.55	28	15	38	1.5	0.30	254	< 5	8	1.0	< 0.01	1.44	208	132	160	380
528	29/7/71	0.0	8.3	0.55	18	11	50	1.1	0.31	237	< 5	5	1.2	0.67	2.29	194	88	220	352
762	15/3/62	–	8.2	0.60	–	–	–	–	–	215	–	127	–	–	–	176	72	–	–
800	24/7/71	0.0	8.3	0.55	11	6	103	1.8	1.3	261	< 5	43	1.5	< 0.01	6.21	214	52	270	508
853	23/7/71	> 5.0	8.3	0.20	21	13	61	1.7	0.49	232	37	16	1.3	< 0.01	2.57	190	106	220	425
861	15/3/62	0.0	7.9	1.08	–	–	–	–	–	117	–	57	–	–	–	96	114	–	–
960	28/7/71	0.0	7.3	0.05	98	20	44	8.9	0.24	237	74	83	0.2	8.0	1.06	194	328	500	778
1146	18/1/56	–	7.9	–	14	10	–	–	–	237	–	–	1.5	–	–	194	74	–	–
1213	27/7/71	0.0	7.2	14.0	94	46	86	3.3	0.69	734	< 5	20	0.4	0.01	1.82	610	424	620	1029
1214	26/7/71	0.0	8.1	0.15	15	15	44	0.9	0.34	202	17	9	1.2	0.25	1.92	166	100	190	359
1268	23/10/64	–	8.0	0.40	–	–	–	–	–	241	2	2	–	–	–	198	116	–	–
E-6	15/3/62	–	7.7	0.48	–	–	–	–	–	349	–	127	–	–	–	286	74	–	–

Table 3. Laboratory Analyses—Shallow Aquifers

Sample or Well Number	Date	H_2S at Field	pH at Lab	Constituents in parts per million (ppm)											Sodium Adsorption Ratio	Alkalinity as ppm $CaCO_3$	Total Hardness as ppm $CaCO_3$	Total Dissolved Solids (ppm)	Specific Conductance (micromhos at 25°C)
				Total Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Boron (B)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (N)					
24	13/10/70	–	8.4	0.65	8	7	231	1.8	–	201	2	280	–	< 0.01	14.34	165	48	670	–
84	7/7/71	0.0	8.0*	0.85	152	19	9	6.4	0.10	414	118	10	< 0.1	0.35	0.18	339	460	630	820
98	15/7/65	–	8.1	0.22	56	8	2.3	1.6	–	117	72	8	–	0.54	0.08	96	172	242	290
118	15/7/65	–	7.7	0.02	87	12	11.6	3.45	–	350	55	16	–	3.02	0.31	287	270	382	500
121	15/7/65	–	7.8	0.10	112	12	11.6	6.25	–	229	101	20	–	20	0.28	188	332	532	620
197	7/7/71	0.0	7.9*	< 0.05	129	19	6	0.8	0.07	272	49	46	< 0.1	22	0.13	223	398	580	772
275	7/7/71	0.0	–	< 0.05	74	15	8	29	0.15	224	67	14	< 0.1	5.7	0.22	184	244	450	568
316	15/7/65	–	7.8	0.70	86	12	2.1	1.55	–	283	71	10	–	2.40	0.06	232	262	362	430
414	7/7/71	0.0	–	3.10	82	13	5	0.8	0.06	217	60	17	0.1	0.03	0.14	178	258	350	491
574	7/7/71	0.0	–	< 0.05	125	16	10	2.3	0.10	246	58	35	< 0.1	29	0.22	202	376	640	780
631	16/6/60	0.0	7.2	0.20	–	–	–	–	–	378	–	13	–	–	–	310	448	–	–
749	6/7/71	0.0	7.8*	0.10	47	18	24	2.1	0.15	250	21	14	0.9	0.13	0.75	205	190	300	450
772	6/7/71	0.0	7.8*	0.05	18	6	68	0.9	0.35	139	81	7	0.8	0.21	3.55	114	68	300	413
784	15/3/62	–	7.5	4.40	–	–	–	–	–	459	–	22	–	–	–	376	362	–	–
789	6/7/71	0.0	7.5*	0.15	120	28	11	1.4	0.09	395	79	16	0.4	0.30	0.24	324	416	540	760
882	6/7/71	0.0	–	< 0.05	129	14	91	15	0.16	336	51	171	< 0.1	8.3	2.03	276	380	850	1190
975	27/4/72	–	8.1	0.30	104	17	–	–	–	354	140	20	0.4	12	–	290	330	–	670
1030	26/7/71	0.0	7.7	2.50	84	16	5	0.9	0.06	254	64	6	0.1	< 0.01	0.13	208	274	300	492
1041	7/7/71	0.0	7.7*	0.10	84	18	7	1.0	0.08	251	74	6	< 0.1	0.03	0.18	206	284	380	535
1053	6/7/71	0.0	–	0.05	106	15	3	0.9	0.09	202	35	27	< 0.1	28	0.07	166	328	550	650
E-1	24/4/63	–	7.8	0.00	–	–	–	–	–	173	–	16	–	–	–	142	200	–	–
E-4	11/5/71	–	7.5	0.05	98	18	4	1.0	–	276	33	25	–	9.5	0.10	226	316	–	–

*pH at field

Table 2. Field Analyses—Deep Aquifers

Sample or Well Number	Date	H_2S	pH	Total Iron	Chloride	Alkalinity	Total Hardness
40	20/7/71	0	7.3	0.5	182	222	154
42	19/7/71	0.1	8.1	1.5	242	137	103
357	21/7/71	0	7.8	3.6	969	137	496
358	19/7/71	0.01	7.8	1.2	364	171	154
360	21/7/71	0	8.3	2.9	303	239	222
362	21/7/71	0	7.3	> 5.0	575	154	239
386	22/7/71	0	7.7	1.1	515	86	342
395	28/7/71	0	7.8	2.5	212	222	120
418	28/7/71	0	8.0	2.0	121	205	103
692	27/7/71	0	7.8	4.0	20	222	222
732	29/7/71	0	7.9	0.5	15	205	120
790	22/7/71	0	9.3	> 5.0	666	239	291
880	23/7/71	0	7.9	3.5	272	257	137
899	22/7/71	0	7.8	2.4	636	103	394
1261	27/7/71	0	7.8	2.7	18	274	188

Table 4. Field Analyses—Shallow Aquifers

Sample or Well Number	Date	H_2S	pH	Total Iron	Chloride	Alkalinity	Total Hardness
46	19/7/71	0	7.4	0	91	702	342
102	28/7/71	0	7.7	0.5	55	119	205
114	28/7/71	0	7.4	0.5	50	171	359
274	29/7/71	0	7.8	0.6	20	188	188
402	27/7/71	0	7.8	0.6	20	154	205
425	29/7/71	0	7.2	0.6	60	513	496
768	22/7/71	0	7.9	0	30	274	205
776	24/7/71	0	7.4	0	25	308	410
814	22/7/71	0	7.9	2.4	60	394	428
860	22/7/71	0	7.1	0.9	60	359	462
990	26/7/71	0	7.3	1.0	50	188	274
1242	23/7/71	0	7.1	1.7	50	410	531

ONTARIO
MINISTRY OF THE ENVIRONMENT
Water Quantity Management Branch

GROUND WATER PROBABILITY MAP

COUNTY OF ELGIN

MAP 3106-1

DEEP AND SHALLOW AQUIFERS

Scale 1:100,000

1 inch equals 1.58 miles

Miles

Kilometres

Published 1972

Transverse Mercator Projection

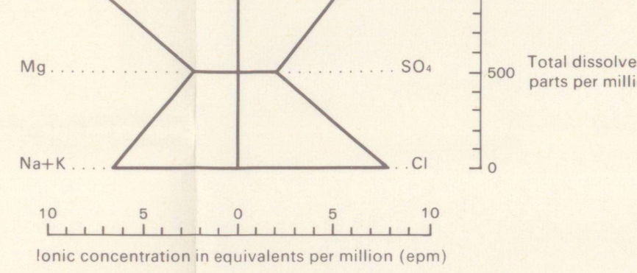
Published 1972

Transverse Mercator Projection

LEGEND

- Areas where wells are likely to produce less than two gallons per minute. Difficulties are encountered in obtaining sufficient quantities of water for any purpose.
- Areas where wells are likely to produce two to ten gallons per minute. Supplies are generally adequate for domestic and stock purposes.
- Areas where wells are likely to produce ten to fifty gallons per minute. Supplies are generally plentiful for domestic and stock purposes, adequate for most commercial and small industrial purposes, but poor to fair as a supplemental source for irrigation.
- Areas where wells are likely to produce more than fifty gallons per minute. Supplies are generally adequate for most irrigation and many municipal uses.
- Areas where no significant intermediate aquifers are present or developed.
- Approximate boundary between intermediate aquifers at different elevations. Arrows are pointing to lower elevations.
- B_1 — B_2 Lines of hydrogeological cross-sections. Cross-sections are shown on Map 3106-1.

EXPLANATION OF WATER QUALITY DIAGRAM



CONVERSION FACTORS

Equivalents per million (epm) to parts per million or to milligrams per litre:

Ion	Multiply by
Bicarbonate (HCO_3)	61.01
Calcium (Ca)	20.04
Chloride (Cl)	35.46
Magnesium (Mg)	12.16
Potassium (K)	39.10
Sodium (Na)	23.00
Sulphate (SO_4)	48.04

SYMBOLS

Line of equal depth to the intermediate aquifers in the overburden, interval 25 feet 50

Assumed depth to the intermediate aquifers in the overburden, interval 25 feet 50

Well with laboratory analysis ....

Well with field analysis ....

Sample and well number / Depth of water-yielding zone in feet .... 260 / 73

Sample and well number / Depth of well in feet .... E-1 / 90

Water quality diagram:

Concentrations to scale ....

Topographic symbols:

Multilane, limited access highway 401

Provincial highway 78

County road 25

Other road

Railway

Perennial river or stream

Intermittent stream

Ditch

Marsh or swamp

County boundary

Township boundary

City, town or village limit

Park or reserve boundary

Concession line

Lot line

Built-up area

Centre of settlement

SOURCES OF INFORMATION

Probability of ground water by A. A. Mellary and B. Novakovic, 1971.

Water samples taken by B. Novakovic, 1971.

Water samples analyzed by OWRC Laboratory and by B. Novakovic.

Well information from:

Water-well records on file with the Ontario Water Resources Commission.

Oil and gas well records published by the Petroleum Resources Section of the Ontario Department of Mines and Northern Affairs.

Base map derived from 1:25,000 and 1:50,000 sheets of the National Topographic Series, and from Ontario Department of Highways maps.

Cartography by R. Zimmermann, 1972.

CHEMICAL ANALYSES OF WATER SAMPLES

Table 5. Laboratory Analyses—Intermediate Aquifers

Sample or Well Number	Date	H_2S at Field	pH at Lab	Total Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Boron (B)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (N)	Sodium Adsorption Ratio	Alkalinity as ppm $CaCo_3$	Total Hardness as ppm $CaCo_3$	Total Dissolved Solids (ppm)	Specific Conductance (micromhos at 25°C)
				Constituents in parts per million (ppm)															
72	13/10/70	0.0	7.8	0.40	19	7	67	2.2	–	145	1	75	–	< 0.01	3.33	119	76	270	–
113	28/7/71	Trace	7.9	0.85	43	14	11	0.9	0.17	219	< 5	5	0.3	< 0.01	0.37	180	162	160	331
134	15/7/65	–	8.2	3.9	20	8	85	1.75	–	314	0	17	–	0.0	4.07	257	82	326	410
145	15/7/65	–	7.7	0.52	89	14	3.6	1.55	–	290	41	4	–	Trace	0.09	238	280	336	450
150	29/7/71	0.0	8.3	0.10	14	7	38	0.7	0.29	132	15	15	1.0	0.04	2.06	108	64	160	273
160	15/7/65	–	7.6	3.61	98	21	8.8	2.7	–	184	82	19	–	0.0	0.21	151	330	478	550
178	29/7/71	0.0	7.6	0.10	110	15	4	1.7	0.16	334	43	11	0.1	2.7	0.09	274	336	390	583
337	15/7/65	–	7.6	1.3	90	22	5.4	1.1	–	334	40	5	–	0.0	0.13	274	314	362	495
338	28/7/71	0.0	7.5	1.1	92	22	6	1.0	0.19	332	42	7	0.1	0.02	0.15	272	320	360	557
461	7/7/71	0.0	7.8*	0.15	29	20	43	1.1	0.29	223	44	3	1.2	0.23	1.50	183	154	300	453
548	27/7/71	0.0	7.9	0.25	23	14	76	1.2	0.41	327	< 5	8	1.2	< 0.01	3.08	268	114	300	493
604	7/7/71	–	–	0.10	10	3	68	0.8	0.34	149	36	24	1.4	0.16	4.83	122	38	250	376
612	29/7/71	0.0	7.5	3.2	46	17	86	1.7	0.46	435	< 5	25	0.6	< 0.01	2.75	357	186	340	682
637	18/1/56	–	7.7	–	21	30	–	–	–	300	–	–	–	–	–	246	174	–	–
661	22/10/64	–	8.0	0.51	–	–	–	–	–	210	0	2	–	–	–	172	96	–	–
681	27/7/71	0.0	8.3	0.15	10	4	39	0.6	0.25	149	< 5	4	1.3	0.01	2.64	122	44	130	229
683	22/10/64	–	8.1	0.41	–	–	–	–	–	217	7	2	–	–	–	178	134	–	–
688	8/7/71	–	8.2*	0.45	23	14	33	1.0	0.14	198	32	2	1.2	0.02	1.33	162	112	210	334
695	23/10/64	–	8.3	0.29	–	–	–	–	–	163	0	4	–	–	–	134	64	–	–
791	22/7/71	0.0	7.9	0.25	34	12	129.	1.1	0.37	78	23	227	1.2	0.02	4.84	64	134	490	888
869	23/7/71	0.0	8.1	1.2	33	11	100	0.9	0.41	102	182	48	1.1	0.07	3.85	84	126	420	689
872	23/7/71	0.0	8.3	0.10	12	4	74	0.8	0.28	127	35	42	1.4	0.07	4.72	104	46	200	412
1006	26/7/71	0.3	8.4	0.25	9	3	72	0.9	0.42	176	13	19	1.3	< 0.01	5.29	144	34	180	348
1195	22/7/58	–	8.4	0.7	–	–	–	–	–	–	–	91	1.4	–	–	–	79	–	–
1198	26/7/71	0.0	8.4	0.10	9	4	85	1.4	0.45	227	< 5	24	1.5	< 0.01	5.93	186	40	220	403
1208	6/7/71	0.0	7.8*	0.95	55	17	12	1.4	0.15	276	< 5	3	0.8	< 0.01	0.36	226	208	300	423
1215	-26/7/71	0.0	8.2	0.15	14	11	46	0.9	0.33	188	15	7	1.2	0.18	2.24	154	80	190	328
1253	22/10/64	–	8.3	0.73	–	–	–	–	–	175	23	3	–	–	–	144	64	–	–
1255	22/10/64	–	8.0	1.10	–	–	–	–	–	222	11	Trace	–	–	–	182	164	–	–
1257	22/10/64	–	8.0	0.72	–	–	–	–	–	227	0	9	–	–	–	186	92	–	–
1320	26/7/71	0.0	7.7	2.6	71	15	6	1.1	0.14	285	9	4	0.5	< 0.01	0.17	234	240	240	441
1348	18/1/56	–	8.1	–	26	30	–	–	–	270	–	–	1.1	–	–	222	186	–	–
1862	18/1/56	–	8.0	–	12	12	–	–	–	300	–	–	–	–	–	246	80	–	–
E-5	15/3/62	–	7.7	0.24	–	–	–	–	–	290	–	22	–	–	–	238	214	–	–

*pH at field

Table 6. Field Analyses—Intermediate Aquifers

Sample or Well Number	Date	H_2S	pH	Total Iron	Chloride	Alkalinity	Total Hardness
202	29/7/71	0	8.0	0.5	50	154	68
216	29/7/71	0	7.7	1.6	25	222	325
319	29/7/71	0	6.7	0	21	137	102
328	29/7/71	0	7.7	0	25	291	342
486	29/7/71	0	8.1	2.3	15	273	154
516	29/7/71	0	7.7	> 5.0	15	376	308
750	23/7/71	0	8.5	0	30	171	51
827	24/7/71	0	7.7	1.4	90	154	205
830	23/7/71	0	8.4	1.2	60	120	86
998	26/7/71	0	7.8	1.6	151	154	103
1140	26/7/71	0	7.6	3.8	49	274	342
1180	26/7/71	0	7.9	1.2	45	188	137
1188	27/7/71	0	8.7	0.6	20	154	68
1197	26/7/71	Trace	8.6	1.3	51	222	120
1262	27/7/71	0	8.0	2.9	48	171	205
1291	26/7/71	0	7.7	3.0	15	239	274
1350	23/7/71	0	8.7	1.5	55	188	51

ONTARIO

MINISTRY OF THE ENVIRONMENT

WATER QUANTITY BRANCH

GROUND WATER PROBABILITY MAP

COUNTY OF ELGIN

MAP 3106-2

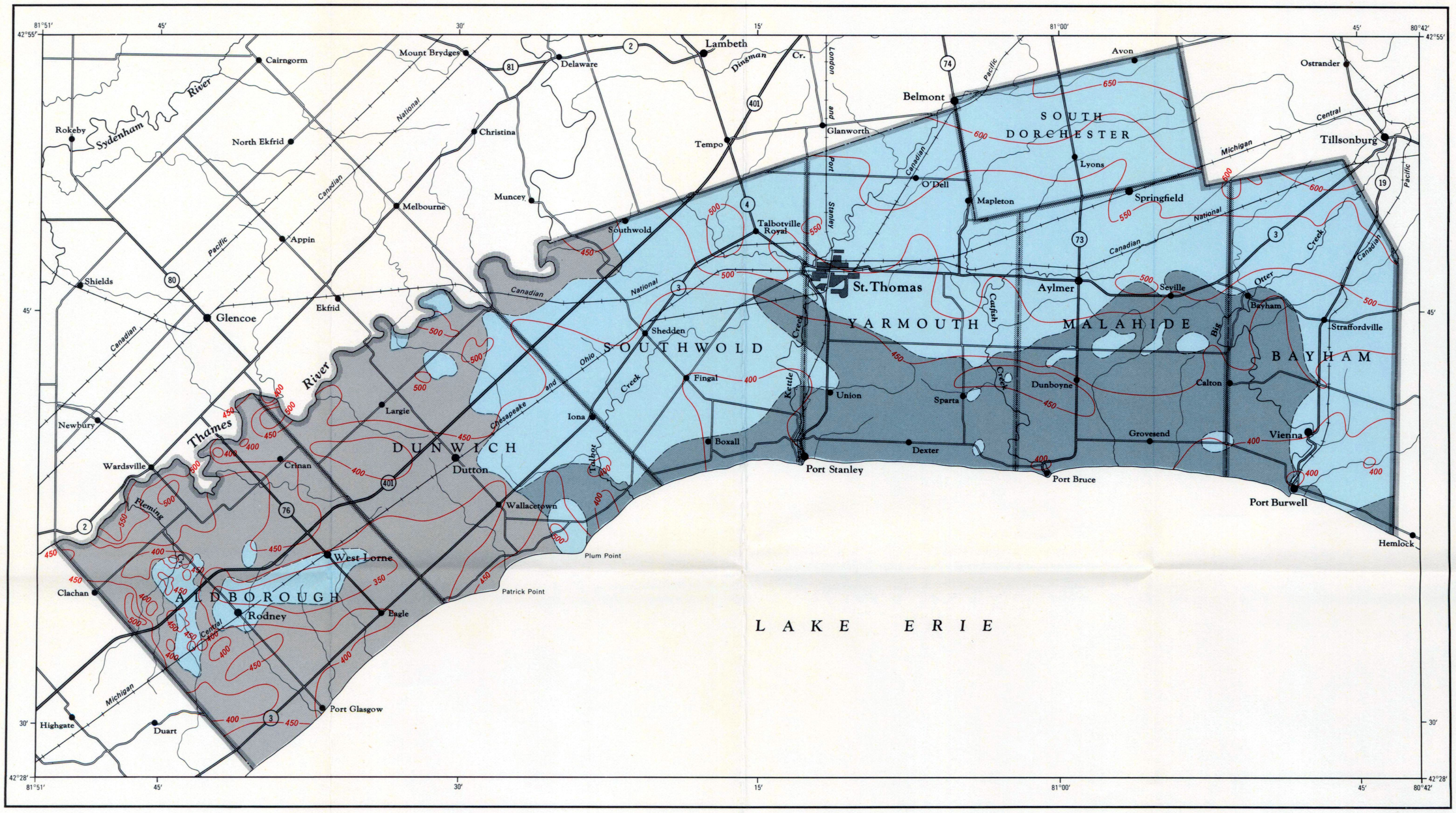
INTERMEDIATE AQUIFERS

Scale 1:100,000

1 inch equals 1.58 miles

Miles

Kilometres



LEGEND

PALAEOZOIC

MIDDLE DEVONIAN

HAMILTON FORMATION: grey shale; argillaceous and crinoidal limestone.

MARCELLUS FORMATION: black bituminous shale and minor limestone.

DUNDEE FORMATION: medium or light brown limestone.

Geological boundary, approximate.

550 Bedrock surface contour, interval 50 feet.

Note: Elevations in feet above mean sea level.

SOURCES OF INFORMATION

Bedrock topography by A. A. Mellary and B. Novakovic, 1972.

References:

Map 1263A, Geology Toronto-Windsor Area, Ontario, by B. V. Sanford; Geological Survey of Canada, 1969.

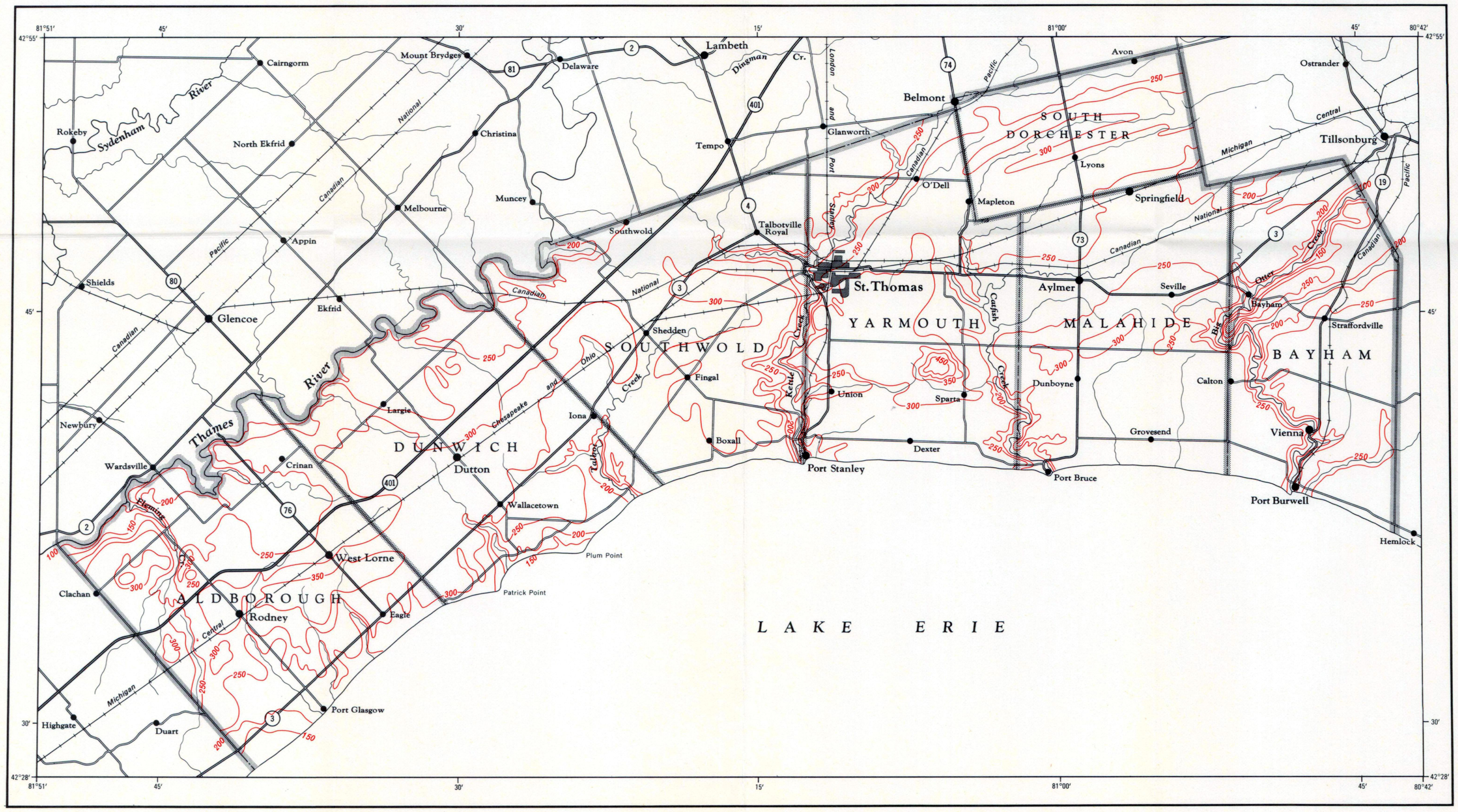
Map 53-6, Elgin County and Parts of Middlesex County drift-thickness and bedrock contours, by B. V. Sanford; Geological Survey of Canada, 1953.

Base map derived from 1:25,000 and 1:50,000 sheets of the National Topographic Series, and from Ontario Department of Highways maps.

Cartography by R. Zimmermann, 1972.

MAP 3106-3

BEDROCK GEOLOGY AND TOPOGRAPHY



LEGEND

250 Line of equal overburden thickness, interval 50 feet.

SOURCES OF INFORMATION

Thickness of overburden by A. A. Mellary and B. Novakovic, 1972.

References:

Map 53-6, Elgin County and Parts of Middlesex County drift-thickness and bedrock contours, by B. V. Sanford; Geological Survey of Canada, 1953.

Well information:

Water-well records on file with the Ontario Water Resources Commission.

Oil and gas well records published by the Petroleum Resources Section of the Ontario Department of Mines and Northern Affairs.

Base map derived from 1:25,000 and 1:50,000 sheets of the National Topographic Series, and from Ontario Department of Highways maps.

Cartography by R. Zimmermann, 1972.

MAP 3106-4

THICKNESS OF OVERBURDEN

ONTARIO

MINISTRY OF THE ENVIRONMENT

Water Quantity Management Branch

COUNTY OF ELGIN

Scale 1:250,000

1 0 1 2 Miles

1 0 1 2 Kilometres